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ABSTRACT

THE RELATIONSHIP BETWEEN INSTRUCTION AND TRANSFER WAS STUDIED TO DETERMINE IF TESTS OF TRANSFER WOULD INFLUENCE EVALUATION OF INSTRUCTION DIFFERENTLY THAN TESTS OF LEARNING OF SPECIFICS. SUBJECTS WERE 120 FOURTH GRADERS OF AVERAGE INTELLIGENCE. THE CHILDREN WERE RANDOMLY ASSIGNED TO ONE OF THE FOLLOWING GROUPS: (1) RULE TREATMENT, (2) SPECIFIC INSTRUCTIONS TREATMENT, (3) ANSWERED PROBLEM TREATMENT, OR (4) CONTROL GROUP. THE THREE EXPERIMENTAL GROUPS WERE GIVEN THE SAME PROBLEMS TO SOLVE AND ONLY THE PROBLEM SOLVING INSTRUCTIONS WERE DIFFERENT. THERE WERE NO STATISTICALLY SIGNIFICANT DIFFERENCES IN COMPETENCE IN SOLVING THE SPECIFIC PROBLEMS AMONG THE THREE GROUPS, BUT THE RULE TREATMENT GROUP PRODUCED THE GREATEST DEGREE OF TRANSFER. IT WAS CONCLUDED THAT TO ATTAIN THE GENERAL GOAL OF TRANSFER, INSTRUCTION ASSOCIATING RULES WITH PROBLEMS WAS PREFERRABLE TO INSTRUCTION WHICH FOCUSED UPON THE PROBLEMS WITHOUT RULES. RECENT WORK LENDS STRONG SUPPORT TO THIS CONCLUSION, BUT IT HAS ALSO BEEN FOUND THAT THE LEVEL OF PERFORMANCE ON BOTH LEARNING AND TRANSFER TASKS DEPENDS HEAVILY ON THE PARTICULAR TASKS INVOLVED. FINDINGS OF THE PRESENT STUDY INDICATE THE NEED TO INCLUDE TRANSFER TESTS TO MEASURE OUTCOMES OF INSTRUCTION IF INSTRUCTIONAL GOALS INCLUDE AFFECTING STUDENTS BEHAVIOR IN CONTEXTS OTHER THAN THOSE IN WHICH THEY WERE LEARNED. (RSM)

TRANSFER OF RULES: THE NEED FOR TESTS OF TRANSFER IN THE EVALUATION OF INSTRUCTION

CSE Working Paper #3
December 1969

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TRANSFER OF RULES: THE NEED FOR TESTS OF TRANSFER IN THE EVALUATION OF INSTRUCTION

M. C. Wittrock and M. H. Jones

CSE Working Paper #3
December 1969

Center for the Study of Evaluation
UCLA Graduate School of Education

In a series of studies by the senior author (e.g., Wittrock, 1963; Wittrock, 1966; Wittrock & Keislar, 1965; Wittrock, Keislar & Stern, 1964; Wittrock & Twelker, 1964) the transfer of instruction has been studied. In these studies, one main finding is that instruction which aims at the learning of a few specifics, without the teacher associating rules to the specifics, does not usually produce transfer to new problems and new situations. Instruction which associates rules to specific problems does produce transfer of these rules to new situations.

One implication of these studies is that tests of transfer should be an important part of evaluation studies, because instruction best for some types of transfer is different from instruction adequate for teaching specific associations. The instruction best for transfer of rules has the learners practice associating the rules to the problems and the specifics they are learning.

In the study reported below we tested the relationship between instruction and transfer described above to determine if tests of transfer would influence our evaluation of instruction differently from tests of learning

of specifics. If our evaluation of instruction is changed by including tests of transfer, we should be aware of this difference and its obvious implications for evaluation studies. One of these implications is that the tests used in evaluation studies should include tests of transfer, if we are interested in how well our students will use their learning in situations different from those occurring during learning, or in the school classroom.

METHOD

Subjects

The 120 fourth graders in this study, 60 boys and 60 girls, were drawn from those children in six classes whose scores were at the 4.0 grade level or above on the paragraph reading and comprehension subtest of the Iowa Test of Basic Skills. Four classes came from the Madrona School and two classes from the Acacia School, both in the Timber Elementary School District, Newbury Park, California.

Within sex, the children were individually assigned at random to the four groups in the experiment. Because of absences, three girls did not complete the study, reducing the N of the study to 117.

Design

The experimental design included three treatments and one control group. The three treatments differed from each other only in the information given to the children with each problem.

All three treatment groups were always given the same problems. In the Rule treatment, each problem was accompanied by a general rule for solving it. Examples of rules and problems are given below in the section on

materials. In the Specific Instructions treatment, the instructions were written to emphasize the particular symbols used with the problems. In the Answered Problem treatment, no rule was given, but for each problem to be solved a sample problem was answered correctly. One-third of the Control group received rules and examples, one-third received specific instructions and examples, and one-third received answered problems and examples. The Control group differed from the three experimental groups in the number of problems they practiced. As is indicated in Table 1, the experimental groups were given 56 problems over a four day period. The Control group was given only four problems on one day.

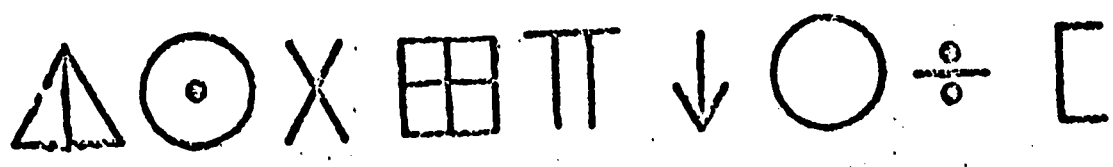
Materials

For the Rule group, four rules (A,B,C, & D) were used consecutively and were then repeated with new problems. The specific instructions and answered problems used were different for each problem. Examples of the materials are presented on the following pages. The bottom of each page contains the answer to the problem, and was folded under at the line.

Table 1

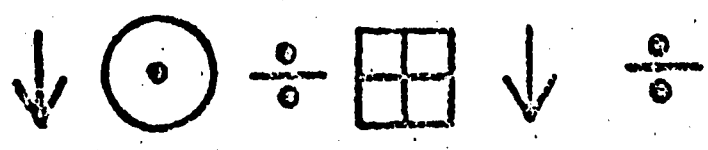
Procedure

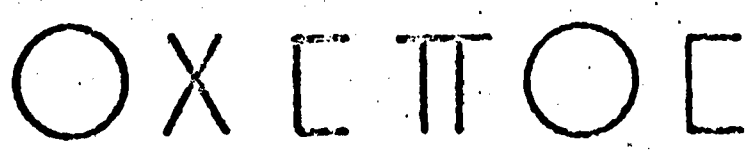
	Day 1 Training	Day 2 Training	Day 3 Training	Day 4 Training & Testing	Day 5 Testing	Day 6 (10 days later)
Rule	Introduction & 16 problems	16 problems	16 problems	8 problems & 8 item posttest	transfer test	repeat of transfer test
Specific Instructions	Introduction & 16 problems	16 problems	16 problems	8 problems & 8 item posttest	transfer test	repeat of transfer test
Answered Problem	Introduction & 16 problems	16 problems	16 problems	8 problems & 8 item posttest	transfer test	repeat of transfer test
Control	Introduction & 4 problems	———	———	8 item posttest	transfer test	repeat of transfer test

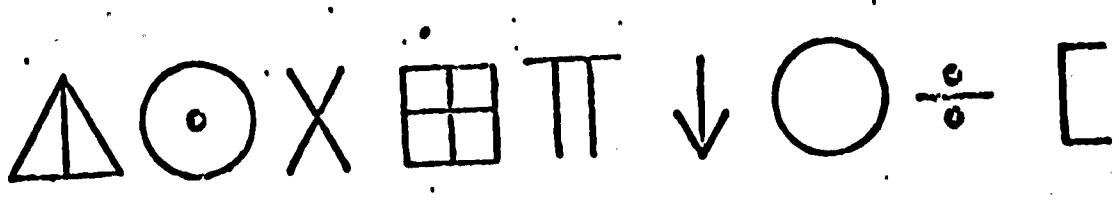


Replace <u>each</u> symbol in the message below with the one that comes <u>just after</u> it in the symbol alphabet above.

Rule A - Rule group







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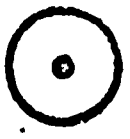
each  with a 

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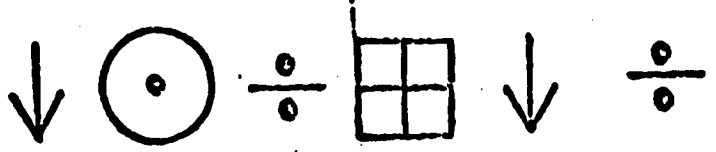
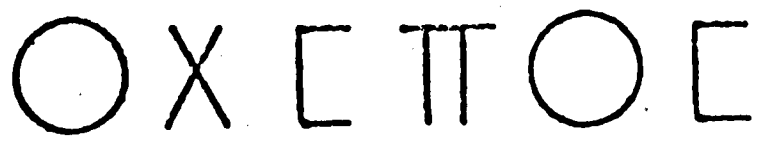
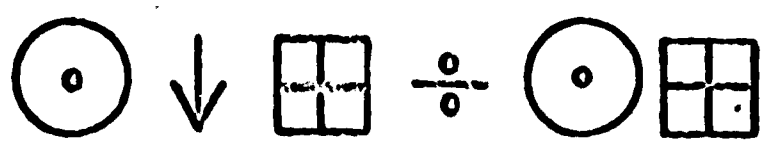
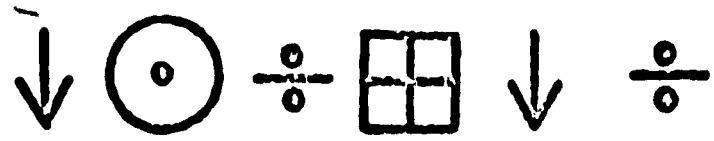




Rule A - Specific Analysis group



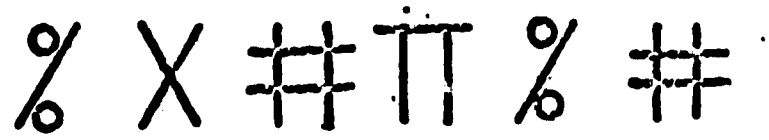


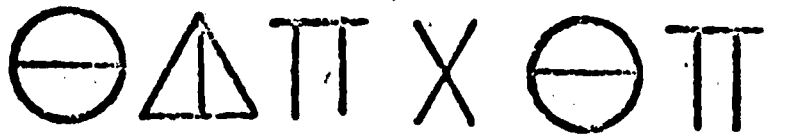
Rule A- Continued Problem group

2

Replace <u>each</u> symbol in the message below with the one that comes <u>two</u> <u>before</u> it in the symbol alphabet above.

Rule B- Rule ?





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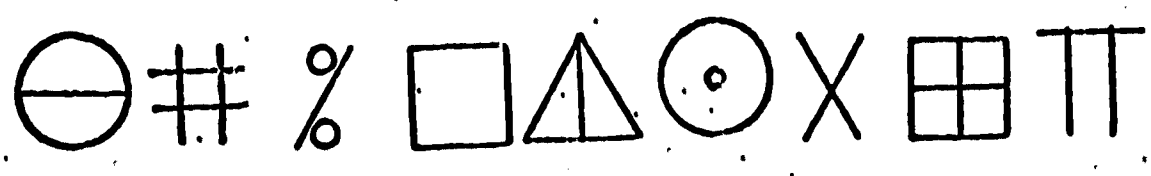

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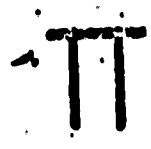
each  with a 

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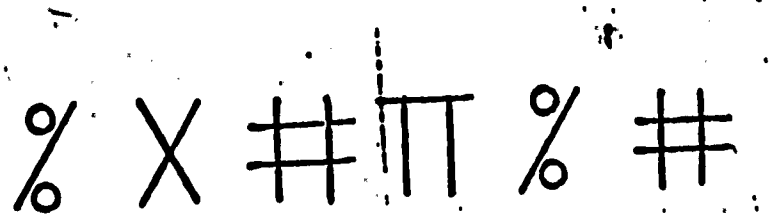
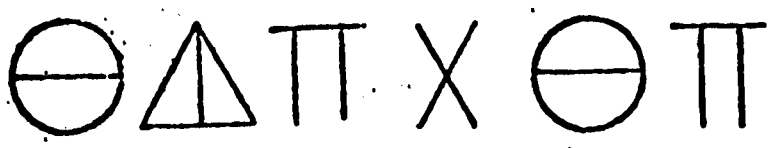
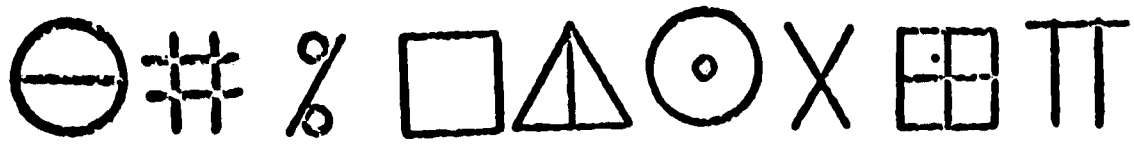
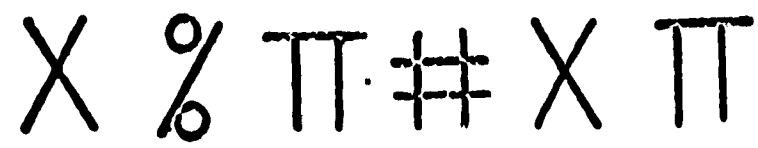


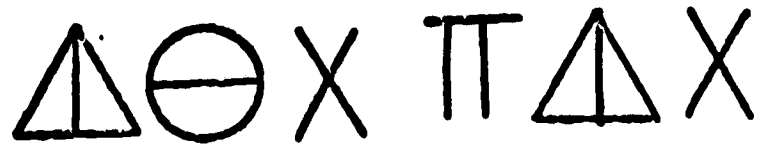


Rule B - Specific Instructions given

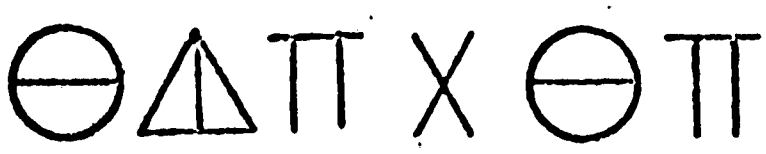
2







Rule B-Answered Problem 2 up



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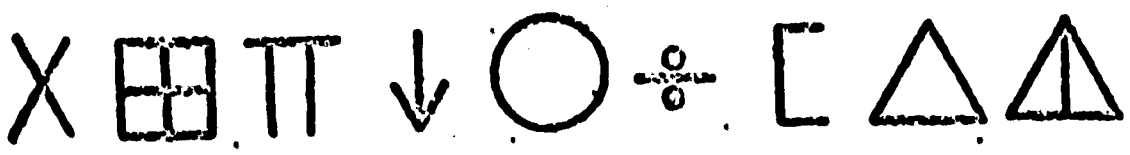
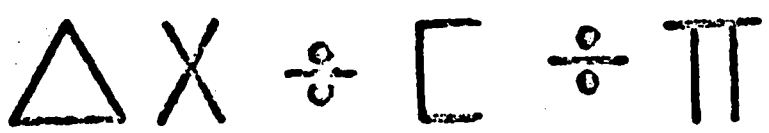


Replace every other symbol in the message below with the one that comes just before it in the symbol alphabet above.

Rule group 3



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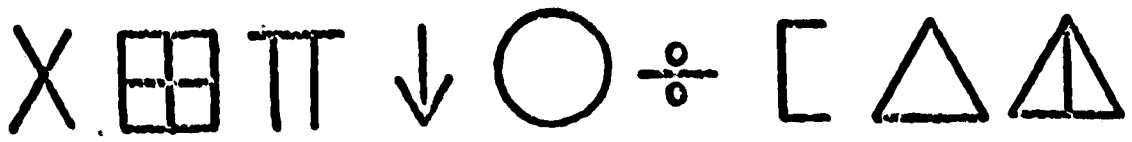

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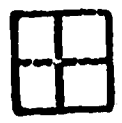
each  with a 

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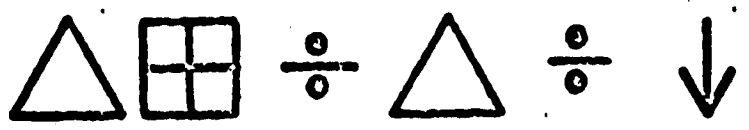
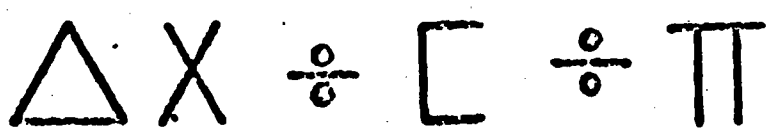
Rule C- Syntactic transformation





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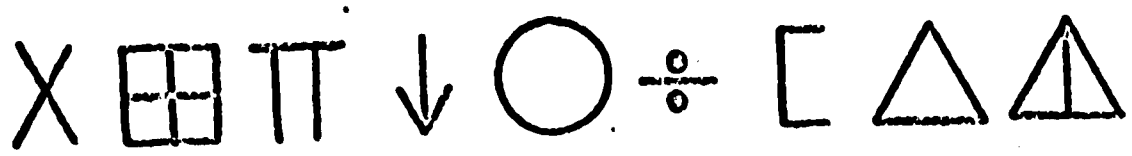
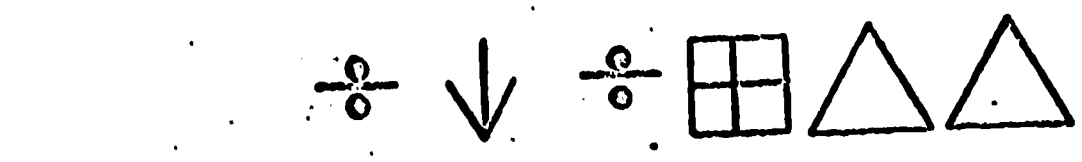
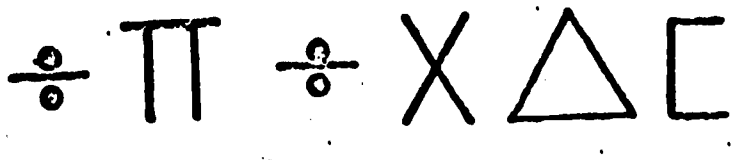
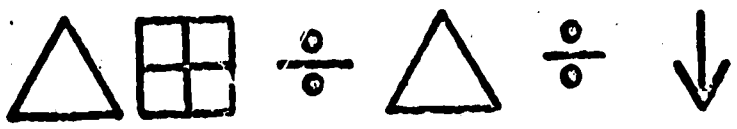
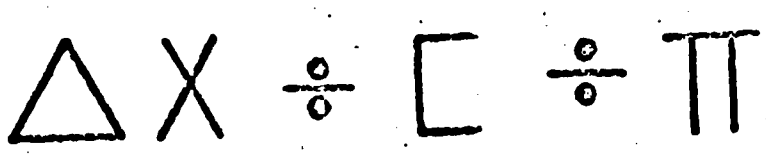








Unanswered Problem given up



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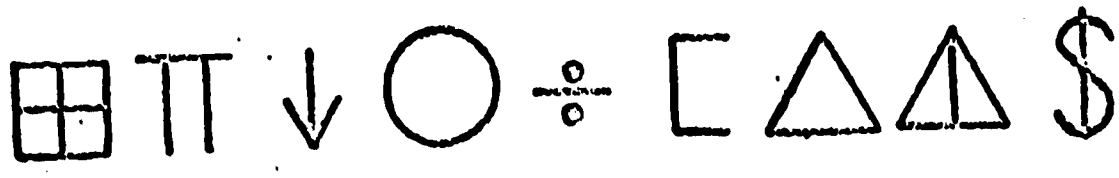
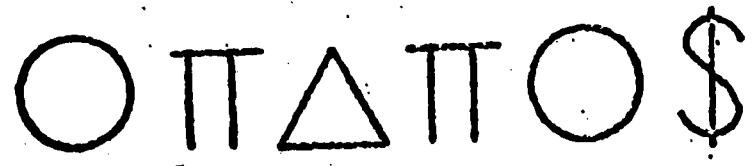
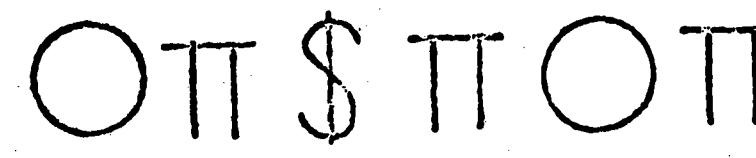


Replace <u>every third</u> symbol in the message below with the one that comes <u>two after</u> it in the symbol alphabet above.

Rule D - Finite group





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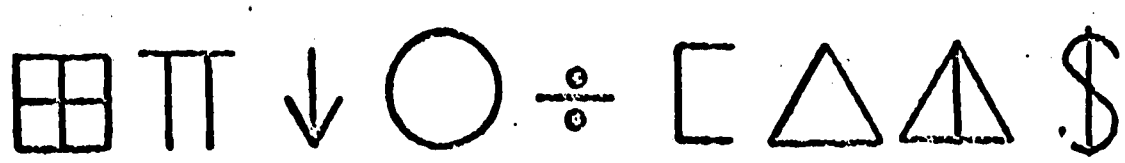

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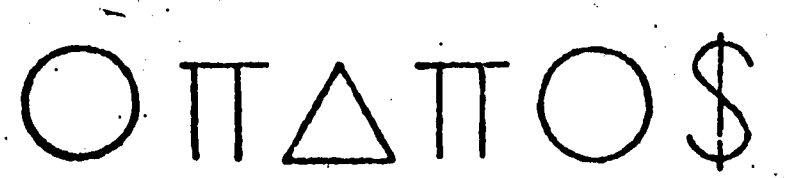

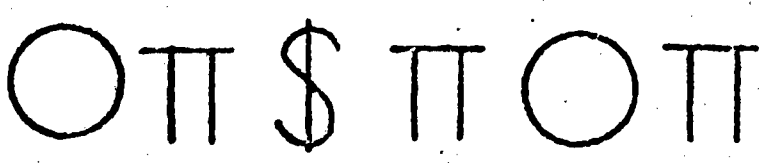

Rule D - Simple Substitution

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Rule D - Answered Problem group

Procedure

The procedure is outlined in Table 1.

On Day 1, Ss in the three treatment groups received a booklet with two pages of introductory material about cryptograms, four problems (one for each of the four general rules) which they worked together with E, and 12 problems which they worked alone. The Control group received a booklet containing the introductory material and the four problems worked with E. The Control booklets did not contain the 12 problems to be worked alone. One-third of the Control group met in the same room with each of the experimental groups. Control group Ss were dismissed after the first four problems were solved.

On Days 2 and 3, the Control group received no materials. A booklet with 16 problems was given to each subject in each experimental group on each day.

On Day 4, Ss in the experimental groups received a booklet with 16 problems, the last eight problems had no KCR. The Control group received booklets with only the last eight problems. These eight problems with no KCR are the posttest.

On Day 5, Ss received a transfer test which consisted of 18 problems, 12 of them with rules given and six without

rules given. The test was divided into five parts: part 1- four problems using the alphabet with each of the training rules, rules stated; part 2- four problems using the training symbols and four new rules, rules stated; part 3- four problems using the alphabet and the four new rules from part 2, rules stated; part 4- four problems using the alphabet with two training rules and two of the new rules from part 2, rules not stated; part 5- two problems using the alphabet and a brand new rule, rule not stated.

On Day 6, ten days after Day 5, all Ss received a retention version of the transfer test.

Instructions

On Day 1, Ss were given booklets and asked to write their names and their birthdays. Ss were then given a starting time.

E read the introduction aloud while Ss followed in their booklets. E paused for questions at the end of the introduction.

The first problem page was introduced as follows:

"This (pointing to symbol strip) is your symbol alphabet. Your secret message is made up with symbols taken from this group."

"This (pointing to message) is the secret message. You will write the decoded message on the line below this message."

"This (pointing to rule or answered problem) is your code to unlock the secret message. Now let's find out how to use the code."

At this point the introduction changed for each treatment group.

Rule group - "Let's read the code and find out how to use it. Notice the underlined words. Read them carefully."

Specific Instructions group - "Let's read the code and find out how to use it."

Answered Problem group - "Let's find out how to use this code. Your code consists of a secret message and the decoded answer to that messgage. The message below will be solved in the same way."

Ss were instructed to draw a line from each symbol in the message to the same symbol in the "alphabet," and to draw a loop from this alphabet symbol to whatever alphabet symbol would replace it in the message.

This was done with all three treatments, although it made little sense to the Specific Instructions group. The

message was then decoded and Ss continued working with E until they finished the fourth problem.

At the end of each page, E repeated the importance of crossing off symbols after they were changed, drawing each symbol directly under the one it was replacing, and following the rules carefully.

Ss were also told the importance of not changing answers once they checked with the answer flap. They were told if they made a mistake they could write the correct answer underneath the answer line if they wished.

Upon completion of the fourth problem, control Ss wrote down an ending time and were dismissed. Experimental Ss continued working on the 12 remaining problems at their own pace. Each S was given help if he made a mistake and did not understand why his answer was wrong. Ss were given ending times as they completed their booklets.

On Days 2 and 3, Ss were given a starting time, reminded to read rules carefully and not to change answers once they checked with the correct answer, etc. Ss were given ending times when they completed the last problem.

On Day 4, Control Ss were given a starting time and told that they could check the correct answer when they finished, since the answer flaps were blank. Experimental Ss were given a starting time and told that the last eight pages had blank answer flaps, and that they could check the answers with E when they finished. All Ss were given ending times when finished and allowed to look at the answer key, without pencils in hand, under E's supervision and away from Ss still working.

On Days 5 and 6, E read through the transfer test with Ss before giving a starting time. For rules C and D (every other changed and every third changed) Ss were told which letter to begin the change with. No further instructions were given.

Upon completion of the first 12 problems, Ss raised hands and received an ending time for that section. They then began work on the problems where rules were not stated. Ss were allowed to give up after five minutes if they became too upset by not having any rules to work with. At the end of 45 minutes all tests were collected. Tests were marked F (finished), G (gave up), and T (time up) as they were turned in.

Results

The dependent variables of the study are: learning, as measured by a posttest; time to take this posttest; transfer to new rules and problems as measured by the transfer test; time to take the transfer test; retention of the ability to transfer as measured by the retest of transfer called the retention test; and time to take the retention test. There were five sub-scores to the transfer test and five sub-scores to its repetition given ten days later. Table 2 below summarizes the analyses of variance of the six dependent variables of this study. The covariable was the reading score on the paragraph reading and comprehension subtest of the Iowa Test of Basic Skills.

From Table 2, the treatment variable is statistically significant in four tests: posttest, errors; posttest, time; transfer test, errors; and transfer test, time. The retest of transfer, called the retention test below, indicates no statistically significant differences for either time or error score.

Table 2

Summary of the Analyses of Covariance of the Dependent Variables

Posttest error score

Source	df	SS	MS	F
Treatment (Between)	3	26.67	8.84	7.62 (p< .01)
Error (Within)	112	130.65	1.17	
Total	115	157.32		
Covariate	1			

Posttest time

Source	df	SS	MS	F
Treatment	3	2940.21	980.07	8.40 (p< .01)
Error	112	13075.42	116.74	
Total	115	16015.63		
Covariate	1			

Transfer test - Total error score

Source	df	SS	MS	F
Treatment	3	70.25	23.42	3.31 (p< .05)
Error	112	792.18	7.07	
Total	115	862.43		
Covariate	1			

Table 2 (continued)

Transfer test - Total time

Source	df	SS	MS	F
Treatment	3	658.48	219.49	3.06 ($p < .05$)
Error	112	8027.39	71.67	
Total	115	8685.87		
Covariate	1			

Retention test - Total error score

Source	df	SS	MS	F
Treatment	3	24.91	8.30	0.904 (NS)
Error	112	1029.07	9.19	
Total	115	1053.98		
Covariate	1			

Retention test - Total time

Source	df	SS	MS	F
Treatment	3	274.28	91.43	1.103 (NS)
Error	112	9286.34	82.91	
Total	115	9560.62		
Covariate	1			

Table 3

Mean Adjusted Errors and Time Scores for the Posttest, Transfer, and Retention Tests

Treatment	Posttest of Learning (errors)	Posttest of Learning (time)	Transfer (errors)	Transfer (time)	Retention (errors)	Retention (time)
Rule	0.70	7.19	2.97	31.62	2.76	29.35
Specific Instructions	0.82	8.30	4.79	34.97	3.90	30.30
Answered Problem	0.58	5.78	4.83	38.31	3.89	33.38
Control	1.78	18.46	3.73	34.45	3.47	30.17

Comparison tests (Winer, 1962, pp. 65-70) were performed on the dependent measures, listed in Table 3, to test the hypothesis that the Rule treatment would produce the greatest mean transfer but not the greatest learning. The hypothesis was supported. The Rule treatment produced mean transfer greater than did the Specific Instructions treatment ($p.<.01$) or the Answered Problem treatment ($p.<.01$). The Rule group also required less time to take the transfer test ($p.<.01$) than did the Answered Problem group. The other differences between pairs of treatment means in time to take the transfer

test were not statistically significant.

The results of comparison tests for the learning posttest errors and learning posttest time scores were also consistent with the above hypothesis. No statistically significant differences were found among the Rule, Specific Instructions, and Answered Problem groups on either of these measures, indicating that the treatments did not differ in learning to solve training problems. However, the Rule group transferred to different types of problems better than did the other two treatments.

For the retention data, the comparison tests indicated no statistically significant differences among the means of the treatment groups, although these differences approach significance and are in the same direction as those found on the first transfer test. The Specific Instructions group and the Answered Problem group increased their mean numbers of correct items on the retention test more than did the Rule group. This difference among groups may have occurred because on the first transfer test, the correct rules for answering 12 of the 18 problems were specified. This transfer test represents the first time that the Specific Instructions group and the Answered Problem group were given rules. Exposure to these rules may have helped to improve their scores on the second transfer test.

Discussion

In previous studies by the senior author, it has been predicted and found repeatedly that instruction which focuses upon specific answers, and only the specific answers being learned, usually produces quick learning of those specifics, but does not usually produce learning which transfers to different situations. However, in these same studies instruction which produced learning that transferred to new situations associated rules to the specific problems.

In other words, giving children answered problems or specific instructions and hoping they will generate or induce rules from these specific problems or instructions does not often work well, at least not with many school youngsters of average ability. Instruction in which the teacher gives rules that apply to many problems, and associates these rules to the problems, has in earlier studies produced transfer of these rules to new problems.

The same result occurred again in this study. In the Rule treatment each child associated rules with problems. This training produced transfer to different problems.

In this study, instruction which emphasized rules was as useful as were the other two procedures used if the criterion is learning to solve a few problems. On this criterion we would evaluate any one treatment as highly as any other treatment.

However, in this study the type of instruction evaluated best depended upon how general were the criteria of instruction. To attain general goals (transfer) instruction that associated rules with problems was most effective and clearly to be preferred to instruction which focused upon the problems without rules. Other recent work, both with adults and with elementary school students, lends strong support to these conclusions (e.g., Di Vesta & Walls, 1969; Klausmeier & Meinke, 1968; Haslerud, 1967; Scandura & Durnin, 1968). However Werdelin (1966 a & b) reported the opposite result: The groups given examples were better in retention and transfer, although worse in the learning situation. This may be, in part, a function of the type of transfer problems used. Evidence has been presented by Haygood and Bourne (1965) and by Scandura and Durnin (1968) that the level of performance on both learning and transfer tasks depends rather heavily on the particular tasks. Haygood and Bourne showed that there are significant differences in difficulty among conceptual rules, and Scandura and Durnin concluded that performance on transfer problems depends upon the particular dimensions involved. These findings indicate that careful analysis of the rules and dimensions involved in transfer, and their relative difficulty, is essential to interpreting the results of transfer studies. There is, in addition, evidence that the sequencing of various kinds of rules in instruction may be very important. Scandura (1969) found that learning a

specific rule may interfere with the subsequent learning of a more general one, whereas the reverse did not hold. Logan and Wodtke (1968) were concerned with a similar problem because of the prevalence in classroom instruction in some subjects of teaching rules-of-thumb (principles of very limited generality) for solving sets of problems. They found that adding a rule-of-thumb after teaching a general principle worsened performance in transfer tasks but not in tasks using the arithmetical operation trained. This result seems to contradict Scandura's finding, but here the general rule seems not to have been thoroughly learned first, hence the situation may have encouraged the student to learn the restricted rule first. In any event, there is sufficient evidence that the transfer problem in classroom situations is complex enough to demand careful analysis, but it is likewise clear that transfer to a broad class of problems (remote transfer, extra-scope transfer) demands instruction in terms of general principles although such training is no guarantee that the student will know where each such principle is to be applied.

For evaluation studies, findings of this study indicate the need to include transfer tests to measure outcomes of instruction. Instruction will be evaluated differently if we include in the evaluation a test of transfer of learning. Instruction which is best for attaining specific goals may not produce the best results when our goals for learning

include transfer and problem-solving strategies.

Evaluation and goals for instruction are intimately related to each other. In evaluation studies, we should include tests of transfer, tests of the generality of learning, if the goals for instruction include affecting students' behavior in contexts other than those in which the students learned.

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